

ASBESTOS

Identified as a toxic air contaminant under California's air toxics program (AB 1807) in 1986.

CAS Registry Number: 1332-21-4

$[\text{Mg}_6(\text{Si}_4\text{O}_{10})(\text{OH})_8]$
Chrysotile

Molecular Formula: See Table I

Asbestos is a commercial name that applies to a number of naturally-occurring, hydrated mineral silicates incombustible in air and separable into filaments. These filaments are long, thin, flaxy fibers that resemble fiberglass. Although insoluble, the fibers may occur in suspension in both air and water. Synonyms for asbestos are asbestos fiber, ascarite, serpentine, amianthus, amphibole, and fibrous grunerite (HSDB, 1995). Asbestos is divided into two mineralogical groups; serpentines and amphiboles. Chrysotile is composed of curly fibers that can shear into smaller fibrils. Its crystalline structure in cross-section looks like rolled up scrolls, whose configuration is due to layered sheets of silicates with outer magnesium as hydroxide ions. Unlike chrysotiles curled shape, amphiboles crystalize in straight, double chains, resulting in a needle-like structure. Amphiboles "chain silicates" are typically more brittle than chrysotile and tend to cleave longitudinally (ARB, 1986b). Asbestos may not rot and possesses extremely high tensile strength as well as resistance to acids, bases, and heat (HSDB, 1995). See Table I for additional physical properties of asbestos fibers.

SOURCES AND EMISSIONS

A. Sources

Sources of asbestos include heat-resistant insulators, cements, furnace and hot pipe coverings, inert filler medium, fireproof gloves, clothing, and brake linings (Merck, 1989).

Although asbestos use in California is decreasing, some of the principal remaining uses are in building materials, paper products, asbestos-cement products, friction products, and packings and gaskets (ARB, 1990f). The primary sources of asbestos emissions in California are metal mining (gold and silver ores), industrial sand and gravel mining, and crushed and broken stone mining (ARB, 1997b). Other sources of emissions are landfills, renovation and demolition of buildings, roads surfaced with gravel containing asbestos, and natural weathering or human disturbance of serpentine rock deposits (ARB, 1986b). Serpentine rock, which may contain asbestos, contains by definition at least 10 percent serpentine, and in California, can contain as high as 90 percent asbestos. It can be used as a surfacing material on other unpaved areas such as roads, parking lots

and driveways (ARB, 1990f). The Air Resources Board (ARB) adopted a control measure in February 1990 that specified that serpentine material could not be used for surfacing unless the material has been tested and determined to have an asbestos content of 5 percent or less (ARB, 1990f).

B. Emissions

The total emissions of asbestos from stationary sources in California is estimated to be at least 4,700 pounds per year, based on data reported under the Air Toxics "Hot Spots" Program (AB 2588) (ARB, 1997b).

C. Natural Occurrence

Asbestos may be released through the erosion of natural deposits in asbestos-bearing rocks. Chrysotile occurs only in serpentine, a fine-grained dull green rock composed of hydrous magnesium silicate minerals similar to chrysotile in chemical composition. In California, it is abundant in the Coast Ranges, Sierra Nevada, and Klamath Mountains of California. Only a few of the amphibole minerals, primarily those that are aluminum poor, become sufficiently fibrous to be used as asbestos. Of these, tremolite and actinolite are the only ones that have been of significance in California. Amosite has not been found in California, and crocidolite and anthophyllite have not been found here in commercial quantities (California Department of Conservation, 1963). Asbestos is a natural contaminant of talc. It represents less than one percent of the samples of cosmetic talcs (HSDB, 1995).

AMBIENT CONCENTRATIONS

No ARB data exist for ambient measurements of asbestos. However, the United States Environmental Protection Agency (U.S. EPA) has compiled data from 48 United States cities that reported mean measurements during 1970 of 230 fibers per cubic meter (U.S. EPA, 1993a).

INDOOR SOURCES AND CONCENTRATIONS

Indoor sources of asbestos may include contaminated clothes of asbestos workers, friable asbestos insulation or surfacing, and consumer products formerly containing asbestos (e.g., hair dryers, spackling compounds) (ARB, 1986b). Friable sprayed asbestos insulation on structural surfaces is the major source of airborne asbestos (NRC, 1981). Sprayed material is applied for building insulation and fireproofing. The U.S. EPA has now banned spray-on application of asbestos-containing materials, except where the fibers are encapsulated with a binder during spraying and are not friable after drying (ARB, 1986b).

The U.S. EPA has measured indoor air asbestos concentrations from 1 to 200 nanograms per cubic meter (ng/m³) (U.S. EPA, 1994a). In 1991, the Health Effects Institute conducted a

literature review to examine reported indoor concentrations of asbestos. The review compiled data based on 1,377 air samples obtained in 198 different buildings containing asbestos not involved in litigation. The mean concentration of asbestos in these 198 buildings ranged from 0.00004 to 0.00243 fibers per milliliter (f/ml). When grouped by building category, the mean concentrations are 0.00051, 0.00019, and 0.00020 f/ml in schools, residences, and public and commercial buildings, respectively, with 90th percentiles of 0.0016, 0.0005, and 0.0004 f/ml, respectively (HEI, 1991).

ATMOSPHERIC PERSISTENCE

Asbestos exists in the particle phase in the atmosphere, and hence is subject to wet and dry deposition. The average half-life and lifetime for particles in the atmosphere is estimated to be about 3.5 to 10 days and 5 to 15 days, respectively (Balkanski et al., 1993; Atkinson, 1995).

Asbestos is exceptionally resistant to environmental thermal degradation and chemical attack. Degradation has been observed in the laboratory under extreme conditions of heat, mechanical stress and acidity. Atmospheric transport involves dispersion and reentrainment of fine asbestos fibers with deposition and burial of fibers in soils and sediments. Asbestos fibers could be reentrained if soils or sediments are disturbed by man-made or natural activities (ARB, 1986b).

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics “Hot Spots” Program (AB 2588). Of the risk assessments reviewed as of April 1996, asbestos was the major contributor to the overall cancer risk in 1 of the approximately 550 risk assessments reporting a total cancer risk equal to or greater than 1 in 1 million and contributed to the total cancer risk in 6 of these risk assessments. Asbestos also was the major contributor to the overall cancer risk in 2 of the approximately 130 risk assessments reporting a total cancer risk equal to or greater than 10 in 1 million (OEHHA, 1996a).

HEALTH EFFECTS

Probable routes of human exposure to asbestos are inhalation and ingestion of drinking water (HSDB, 1995).

Non-Cancer: Chronic inhalation exposure to asbestos can result in delayed and progressive pulmonary changes varying in severity from no clinical impairment to progressive cardiorespiratory failure. These effects include: 1) the presence of asbestos fibers and asbestos bodies in the lung parenchyma; 2) development of pleural thickening and pleural plaques; 3) the occurrence of benign pleural effusions; and 4) interstitial fibrosis or asbestosis (ARB, 1986b). Asbestosis, characterized by shortness of breath and cough, is a progressive disease even after

exposure has ceased and can lead to death (Howard, 1990; Proctor; 1988).

The U.S. EPA has not established a Reference Concentration (RfC) or an oral Reference Dose (RfD) for asbestos. No inhalation studies have been seen for adverse reproductive effects of asbestos in either humans or animals (U.S. EPA, 1994a). Adverse reproductive or developmental effects have not been reported in oral animal studies (ATSDR, 1989).

Cancer: Asbestos is a human and animal carcinogen, and has been documented to cause cancer in humans through inhalation in both occupational and nonoccupational settings. All forms of asbestos should be considered carcinogenic. In occupational studies, asbestos has been associated with an increased incidence of lung cancer and pleural and peritoneal mesothelioma (cancer of the lining of the abdominal cavity) and, to a lesser extent, other neoplasms particularly gastrointestinal and laryngeal cancer. Cigarette smoking acts synergistically with occupational exposure to asbestos in increasing the risk of lung cancer, but not mesothelioma (ARB, 1986b). Long and intermediate-range asbestos fibers ($>5\mu\text{m}$) appear to be more carcinogenic than short fibers ($<5\mu\text{m}$) (ATSDR, 1989). A conversion factor of 100 fibers per 0.003 micrograms can be multiplied by a receptor concentration of asbestos expressed in terms of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) to yield fibers per cubic meter (U.S. EPA, 1985b). The World Health Organization, the U.S. EPA, and the State of California under Proposition 65 do not classify asbestos as a carcinogen *when ingested*.

The U.S. EPA classified asbestos in Group A: Human carcinogen based on sufficient epidemiological evidence, and determined an inhalation potency value of $2.3 \times 10^{-1} (\text{fibers}/\text{m}^3)^{-1}$. The U.S. EPA estimates that, if an individual were to breathe air containing asbestos at $4 \times 10^{-6} \text{ fibers}/\text{m}^3$ over a lifetime, that person would theoretically have no more than a 1 in 1 million increased chance of developing cancer (U.S. EPA, 1994a). The International Agency for Research on Cancer classified asbestos in Group 1: Human carcinogen based on sufficient evidence in humans (IARC, 1987a).

The State of California has determined under Proposition 65 that asbestos is a carcinogen (CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is $1.9 \times 10^{-4} [1/(100 \text{ phase contrast microscopy (PCM) fibers per cubic meter})]$ (OEHHA, 1994). In other words, the potential excess cancer risk for a person exposed over a lifetime is estimated to be no greater than 190 in 1 million at 100 fibers per cubic meter (OEHHA, 1994).

TABLE I - PHYSICAL PROPERTIES OF ASBESTOS FIBERS

Theoretical Molecular Formula, Substance Name, & CAS Registry Number	Color	Fusion Temperature of Residual Material °C	Texture	Density g/cm ³	Decomposition Temperature °C
[Mg ₆ (Si ₄ O ₁₀)(OH) ₈] chrysotile CAS No: 12001-29-5	usually white to pale green yellow, pink	1500	usually flexible, silky, and tough	2.55	450 - 700
[Na ₂ Fe ₃ ²⁺ Fe ₂ ³⁺ (Si ₈ O ₂₂)(OH) ₂] crocidolite CAS No: 12001-28-4	blue	1200	flexible to brittle and tough	3.3 - 3.4	400 - 600
[Fe ₅ Mg ₂ (Si ₈ O ₂₂)(OH) ₂] amosite CAS No: 12172073-5	light grey to pale brown	1400	usually brittle	3.4 - 3.5	600 - 800
[(Mg, Fe) ₇ (Si ₈ O ₂₂)(OH) ₂] anthophyllite CAS No: 77536-67-5	white to grey pale brown	1450	usually brittle	2.85 - 3.1	600 - 850
[Ca ₂ Mg ₅ (Si ₈ O ₂₂)(OH) ₂] tremolite CAS No: 77536-68-6	white to grey	1315	usually brittle	2.9 - 3.1	950 - 1040
[Ca ₂ (Mg, Fe) ₅ (Si ₈ O ₂₂)(OH) ₂] actinolite CAS No: 77536-66-4	pale to dark green	1400	---	3.0 - 3.2	620 - 960

(ARB, 1986b; Sax, 1989; Merck, 1989)

